Internal Limiting Membrane Flap Transplantation into the Optic Disc Pit with Two Different Internal Limiting Membrane Peeling Techniques in Optic Disc Pit Maculopathy

Optik Disk Pit Makülopatide İki Farklı İç Sınırlayıcı Membran Soyma Tekniği ile Optik Disk Pit'e İç Sınırlayıcı Membran Flep Transplantasyonu

Mehmet Fatih KÜÇÜK^{1,2*}, Muhammet Kazım EROL²,

1. Department of Ophthalmology, Alanya Alaaddin Keykubat University Faculty of Medicine, Antalya, TURKEY

2. Department of Ophthalmology, Health Sciences University Antalya Education and Research Hospital, Antalya, TURKEY

*Corresponding author: Mehmet Kucuk (MD), Alanya Alaaddin Keykubat University Faculty of Medicine Alanya/Antalya, 07070, TURKEY

E-mail: mehmet.kucuk@alanya.edu.tr

Phone: +90 242-510 61 35

Fax: +90 242 5106139

ORCID: 0000-0002-2548-7869

Abstract

Purpose: To report four patients with optic disc pit-maculopathy (ODP-M) treated with transplantation of internal limiting membrane (ILM) flap, obtained by two different ILM peeling techniques, into the optic disc pit (ODP).

Method and Patients: One eye of 4 patients with ODP-M underwent 23 gauge pars plana vitrectomy. Three patients underwent ILM peeling, free ILM flap transplantation to ODP, and 15-17% perfluoropropane (C3F8) gas tamponade. In these 3 patients, the ILM was transplanted to ODP after complete peeling. In one patient, the nasal fragment of the ILM was left unpeeled and then the peeled ILM flap was folded over the unpeeled portion and transplanted into ODP.

Results: Serous macular detachment and intraretinal multilayered fluid regressed at the end of the postoperative 3rd month in all cases. In all patients, macular thickness decreased and best-corrected visual acuity (BCVA) increased in the postoperative 3rd month. An unexpected macular hole (MH) developed in two patients (Case 2, 3). In one of these patients, MH was closed by peeling the wider ILM, and it was observed that BCVA increased.

Conclusions: ILM flap transplantation to ODP has been observed as an effective surgical technique for the treatment of ODP-M. In addition, a wider ILM peeling was observed to be effective in closure of the permanent MH that developed after ILM transplantation to ODP.

Keywords: Optic disc pit; Optic disc pit-maculopathy, Inverted internal limiting membrane flap transplantation; Free internal limiting membrane flap transplantation; Macular hole

Özet

Amaç: İki farklı iç sınırlayıcı membran (İSM) soyma tekniği ile elde edilen İSM flebinin optik disk pit'e (ODP) transplantasyonu yapılarak tedavi edilen optik disk pit-makülopatili (ODP-M'li) dört hastanın sunumu.

Metod ve Hastalar: ODP-M'li 4 hastanın bir gözüne 23 gauge pars plana vitrektomi uygulandı. Üç hastaya İSM soyulması, ODP'e serbest İSM flep transplantasyonu ve %15-17 perfluoropropan (C3F8) gaz tamponadı uygulandı. Bu 3 hastada, İSM tamamen soyulduktan sonra ODP'e transplante edildi. Bir hastada, İSM'nin nazal parçası soyulmadan bırakıldıktan sonra İSM'nin soyulmuş parçası soyulmamış kısım üzerine katlanarak ODP'e transplante edildi.

Bulgular: Tüm olgularda postoperatif 3. ayın sonunda seröz makula dekolmanı ve intraretinal çok tabakalı sıvı geriledi. Ameliyat sonrası 3. ayda tüm hastalarda makula kalınlığı azaldı ve en iyi düzeltilmiş görme keskinliği (EİDGK) arttı. İki hastada (Olgu 2, 3) beklenmedik bir makula deliği (MD) gelişti. Bu hastalardan birinde daha geniş İSM soyulmasıyla MD kapandığı ve EİDGK'nin arttığı gözlemlendi.

Sonuçlar: ODP'e İSM flep transplantasyonu, ODP-M tedavisinde etkili bir cerrahi teknik olarak gözlenmiştir. Ayrıca ODP'e İSM transplantasyonu sonrası gelişen kalıcı MD'in kapatılmasında ikincil daha geniş İSM soyulmasının etkili olduğu gözlemlendi.

Anahtar Kelimeler: Optik disk pit; Optik disk pit-makülopati, Kıvrılmış iç sınırlayıcı membran flebi transplantasyonu; Serbest iç sınırlayıcı membran flebi transplantasyonu; Makula deliği

Received: 01/08/2021

Accepted: 14/11/2021

Published Online: 02/12/2021

Cite this article: Kucuk MF., Erol MK. Internal Limiting Membrane Flap Transplantation into the Optic Disc Pit with Two Different Internal Limiting Membrane Peeling Techniques in Optic Disc Pit Maculopathy. Turk J Health S. 2021;2(3):pp.36-41.

Introduction

Optic disc pit (ODP) is a cavitation caused by a congenital developmental defect in the optic disc (OD) [1]. 25-75% of ODP cases develop maculopathy in which the retinal pigment epithelial layer changes after the accumulation of fluid in the retinal layers and / or subretinal region [2, 3]. The origin of the fluid in optic disc pit-maculopathy (ODP-M) is controversial [4, 5]. The debate over ODP-M began with the ODP-M study of K.T.A Halbertsman (1927), who claimed that maculopathy, reported by James in 1913, did not develop due to ODP [6].

ODP-M usually occurs between the ages of 30 and 40 [7], but has also been reported in children [8]. Best-corrected visual acuity (BCVA) regresses up to 20/70 or even more [9]. Patients with a reduction in BCVA of up to 20/200 have been reported, as well as patients with spontaneous improvement [10]. Although surgical treatment is discussed, there are also clinics where different surgical procedures are performed due to the development of significant vision loss in many untreated cases [10, 11]. Because of the importance of vitreopapillary traction in ODP development, pars plana vitrectomy (PPV) is currently the most widely accepted treatment modality [1, 12, 13]. Furthermore, treatment methods in addition to PPV are discussed due to the unknown source of the fluid and different clinical approaches [11, 14]. Peeling of the internal limiting membrane (ILM), gas tamponade, temporal endolaser photocoagulation, injection of autologous platelet, temporal-side single radial optic neurotomy, transplantation of an ILM piece to ODP are some of the adjuvant treatments discussed [15-20].

Some recent studies have shown that ILM flap transplantation to ODP is an effective surgical technique. [21-28]. In this study, we present the results of different methods of this new surgical technique, about which there are few studies in the literature.

Methods

Four eyes of four patients with ODP-M were treated and followed up with the technique of ILM flap transplantation to ODP. Informed consent was obtained from each patient regarding the use of clinical data. The study was compliant with the 1964 Helsinki declaration. Pre and postoperative comprehensive eye examinations were performed in all patients, including BCVA, slit lamp biomicroscopy, tonometry measurements, and fundus examinations. Fundus autofluorescence photograph and color fundus photographs were performed with Visucam NM / FA (Carl Zeiss, Germany). Macular thickness (MT) measurements were performed with Cirrus high-resolution (Optical Coherence Tomography) OCT, model 5000 (Carl Zeiss Meditec Inc., Jena, Germany) and OCT-Angiography (OCT-A) were performed using RTvue 100 OCT-A (Optovue Inc., Fremont, CA).

Surgery

In all patients, 23-gauge PPV was performed. In Cases 1, 3 and 4, ILM was peeled from the temporal region of the macula to the temporal edge of the OD, and a small section on the nasal region of the macula was left unpeeled. ILM was then transplanted into ODP by inverting the flap, which we named 'inverted ILM flap transplantation' (IILMFT). In Case 2, ILM was completely peeled and transplanted into ODP, which we named 'free ILM flap transplantation' (FILMFT). In Cases 2 and 3, a single-row macular barrier endolaser (MBEL) was applied to the nasal region of the macula. Finally, gas tamponade (15-17% C3F8) was performed in all eyes. All the cases were operated on by the same surgeon.

Case 1

Preoperative findings: At the first examination of the 38-year-old male patient, BCVA in the left eye was 20/63. ODP, serous macular detachment (SMD) and intraretinal multilayered fluid (IMLF) were detected in the left eye. The patient was diagnosed with ODP-M in his left eye. The MT was 685 μ in the most raised area. After 13 weeks of follow-up, surgery was planned when BCVA regressed to 20/200, SMD increased, and MT increased to 990 μ (Figure 1a-d).

Figure 1. Preoperative color fundus (a), autofluorescence (b), OCT images (c, d) of Case 1. ODP, SMD, IMLF are seen in a, b, c and d images. Postoperative color fundus (e), autofluorescence (f), OCT images (g, h) of Case 1. Color fundus and autofluorescence were obtained at week 47, OCT images at week 96 postoperatively. ILM flap (white arrow) plugged into ODP is seen (g). Surgical technique: IILMFT

Case 2

Preoperative findings: At the first examination of an 11-year-old female patient, BCVA was 20/200 in the left eye. Based

on the presence of ODP, SMD, and IMLF in the left eye, she was diagnosed with ODP-M. Six weeks later, when BCVA decreased to 20/400 and the MT increased to 1036 μ , surgery was planned (Figure 2a-d).

Figure 2. Preoperative color fundus (a), autofluorescence (b), OCT images (c, d) of Case 2. ODP, wide SMD, and IMLF are seen in a, b, c and d images. Postoperative color fundus (e), autofluorescence (f), OCT images (g, h) of Case 2. Macular hole development is seen in the color fundus (e), autofluorescence (f) and OCT images (g) at the postoperative 20th week. OCT image (h) after the second operation shows that the macular hole is closed. Surgical technique: FILMFT and MBEL during the first operation, and wider ILM peeling during the second operation.

Case 3

Preoperative findings: At the first examination of a 44-year-old female patient, BCVA was 20/200, and SMD and IMLF were detected in the left eye with ODP. Therefore, the patient was diagnosed with ODP-M. Six weeks later, surgical treatment was planned when SMD and the MT increased and BCVA decreased to 20/400 (Figure 3a-d).

Figure 3. Preoperative color fundus (a), autofluorescence (b), optical coherence

tomography images (c, d) of Case 3. ODP, SMD, and IMLF are seen in a, b, c and d images. Postoperative color fundus (e), autofluorescence (f), optical coherence tomography images (g, h) of Case 3. e, f, g, h images were obtained at 52 weeks postoperatively and they show disruption in the photoreceptor layer. Surgical technique: IILMFT and MBEL.

Case 4

Preoperative findings: At the first examination of a 24-year-old female patient, BCVA was 20/400, and ODP, SMD, and IMLF were detected in the left eye; thus, the patient was diagnosed with ODP-M. Additionally, the left eye had a narrowed eyelid at inward gaze, and the fellow eye had restricted outward gaze. After two weeks of follow-up, surgery was scheduled when BCVA decreased to 20/400, the MT increased to 492 μ , and SMD expanded (Figure 4a-d).

Figure 4. Preoperative color fundus (a), autofluorescence (b), OCT images (c, d) of Case 4. ODP, SMD, and wide IMLF are seen in a, b, c and d images. Postoperative color fundus (e), autofluorescence (f), OCT images (g, h) of Case 4. Color fundus, autofluorescence and OCT images were obtained at 43 weeks postoperatively. Surgical technique: IILMFT

Result

Case 1

Postoperative findings: BCVA was 20/25 at 24 weeks postoperatively. SMD and IMLF disappeared at the 24th week. At the postoperative 96th week, the MT decreased to 303 μ (Figure 1e-h).

Case 2

Postoperative findings: BCVA was 20/50 at the 19th week postoperatively. The MT decreased to 456 μ . SMD and IMLF regressed. However, unexpected macular hole (MH) development was observed at the 20th week. Reoperation was performed at the 25th week due to the persistence of MH. At the 64th week, MH closed, SMD disappeared, the MT decreased to 347 μ , and IMLF was no longer seen (Figure 2e-

h).

Case 3

Postoperative findings

We managed to communicate with the patient at the 52nd postoperative week. BCVA was 10/400, the MT was 619 μ , and SMD and IMLF were evident. Unfortunately, we detected an MH with the atrophy of the photoreceptor layer. This is why we were not able to consider secondary surgery (Figure 3e-h).

Case 4

Postoperative findings

At the postoperative 43rd week, BCVA was 20/25, IMLF and SMD disappeared, and the MT decreased to 342 μ (Figure 4e-h).

Discussion

Combined surgical treatments have been used in the treatment of ODP-M in recent years. Although successful results have been reported with different surgical techniques, controversy continues [14-20]. Vitreopapillary and vitreoretinal traction are important in the pathogenesis of ODP-M, and it is thought that fluid is directed to the retina due to the pressure difference caused by traction [13, 29, 30]. It has been shown that intraretinal and subretinal fluid is reduced in ODP-M after PPV surgery to eliminate traction. Similarly, we detected preoperative vitreopapillary traction in our cases and applied PPV to all patients. While PPV is generally considered the main treatment, most studies have also used adjuvant treatments to PPV. Surgical success, side effects, and possible complications of adjuvant treatments are also controversial. [15-20]. One of the reasons for the controversy is that the source of intraretinal or subretinal fluid is unknown. The goal of most adjuvant therapies is to prevent fluid transfer to the retina. The aim here is based on the hypothesis proposed by Jain and Johnson. In this hypothesis, it is claimed that there is a transition between the extraocular region and the intraocular cavities due to a defect in the lamina cribrosa and/or juxtapapillary sclera [1]. Endolaser treatment is one of the adjuvant treatments. Endolaser is used alone or in combination with other adjuvant treatments in PPV. It has been claimed that endolaser therapy alone does not contribute to anatomical success in PPV [31]. In addition, photocoagulation to the edge of the OD to create a barrier has been criticized for the development of permanent scotoma in the maculopapular bundle [15, 32]. In the current study, while we applied endolaser in 2 of our cases (Case 2-3), we did not apply it in the others. However, we did not observe any anatomical or visual differences between our cases.

Surgical outcomes of ILM peeling are also discussed [17]. ILM peeling is claimed to eliminate tangential traction from the retina and help withdraw fluid from the retina [33]. Marticorena et al. reported the dissolution of ODP-M after ILM

peeling to the patient who failed with PPV, gas tamponade, and endolaser [34]. Wider ILM peeling has been shown to cause reduced retinal sensitivity, foveal tissue thinning, and anatomical damage [17, 33, 35]. In our study, we observed MH development and macular changes in Case 2 and 3. However, in Case 2, we observed that persistent MH that developed after ILM transplant to ODP was closed with wider ILM peeling. Similarly, Sborgia et al observed that ILM peeling was more effective in IMLF [25].

Recently, studies have been conducted on the techniques of ILM flap transplantation to ODP to prevent fluid migration caused by ODP. [20-28]. It is claimed that the ILM flap may be a barrier to prevent fluid passage into and under the retina. In these studies, the ILM flap was transplanted to the ODP with two different techniques. In the first technique, the temporal part of the macula was peeled to include the fovea region, while the nasal part of the macula adjacent to the OD was folded without peeling and transplanted to the ODP (IILMFT). In the second technique, the ILM completely peeled from the macula was transplanted to the ODP as a free flap (FILMFT). In our study, we performed the free flap technique in one of four cases and the inverted flap technique in three cases. Different anatomic and functional results have been reported with these techniques. Pastor-Idoate S. et al suggested that folding of the peeled ILM fragment over the macular region left non-peeled (IILMFT) adjacent to ODP may serve as a scaffold for Müller grade cell proliferation and may induce gliosis [28]. Ravani et al. compared these two different ILM transplantation techniques [26]. There are not many studies comparing their efficacy since it is a rare clinical situation. Studies on ILM transplantation to the ODP are mostly in the form of case reports. Our case series seems to be one of the most reported studies with these techniques.

Many cases of spontaneously resolving ODP-M have been reported in the literature [36-38]. If spontaneous recovery was not observed in the studies, the prognosis was not good for patients who were not treated or not treated in a timely manner [37, 38]. It has been suggested that irreversible changes may develop in the pigment epithelial layer and retinal cells due to chronic SMD and IMLF [37-39]. Although the macula was reattached in these cases, it was observed that there was no improvement in visual functions [37]. As suggested in Bloch's study, the development of SMD and visual impairment may be important clinical findings to prioritize surgery [39]. However, Pastor-Idoate S et al reported that the duration of preoperative symptoms did not affect postoperative macular reattachment [28]. Rayat JS et al., on the other hand, have observed that the retinal pigment epithelium-Bruch membrane complex and photoreceptor cells are damaged in chronic and refractive maculopathies [40]. In addition, Spaide et al. observed that photoreceptor apoptosis and subretinal precipitates

prevent visual recovery in chronic or refractory processes [30]. Similarly, we found chronic retinal degenerative findings in Case 3. In this Case with preoperative low BCVA, postoperative vision improved slightly in the first three months but decreased in the 24th month. In 80% of Pastor-Idoate S. et al's cases, structural recovery was prolonged to one hundred and eighty days. In this study, we observed that the structural improvement in Case 1 reached the twenty-fourth week. In Case 3, subretinal and intraretinal fluid was withdrawn in six months. In our second Case, subretinal fluid was not observed after the closure of the MH with ILM in the second surgery. In our second Case, persistent full-thickness MH developed, similar to that reported by Hara [23] and Navrocki [21]. However, in the second operation, we observed that the MH was closed with the transplantation of the ILM obtained by peeling the wider ILM, and then the vision improved. Muhammed OA et al. [20] and Sborgia G et al. [25] reported that BCVA started to improve in the first month and reached expected high levels in the sixth month. However, Pastor et al [28] found this improvement over a longer period. Caporossi et al. observed both visual and structural improvement at ten months and no recurrence at follow-up [27]. Pastor Idoate et al. [28] reported no recurrence within six to twelve months of the follow-up period. Two of the three cases presented by Nawrocki et al [21] were reoperated for recurrence. Pastor et al [28] stated that they did not see the desired level of functional improvement (44%) in the long term in chronic and refractive cases. However, in our study, we observed that BCVA increased as the follow-up periods increased in the first year.

Large case series and long follow-up studies are needed to be considered as successful adjuvant techniques and to compare these techniques. However, in such rare clinical situations, this will not be easy. There are few published studies that we have seen to date and that there are not enough patients in the studies.

In conclusion, ILM flap transplantation to ODP has been observed as an effective surgical technique for the treatment of ODP-M. In addition, a wider ILM peeling was observed to be effective in closure of the permanent MH that developed after ILM transplantation to ODP.

Financial disclosures

The authors have no financial or ownership rights over a product, method, or material mentioned herein.

Declaration of interest

The authors reported no conflict of interest and the authors are solely responsible for the content and writing of the article.

Funding

All Authors declare that they do not receive financial support from any foundation, public or private source.

Ethical approval

Ethical standards All procedures performed in studies involving human participants comply with the ethical standards of the national research committee and the 1964 Declaration of Helsinki and subsequent amendments.

Informed consent

Informed consent was obtained from all patients included in the study.

REFERENCES

- Jain N and Johnson MW. Pathogenesis and treatment of maculopathy associated with cavitory optic disc anomalies. *Am J Ophthalmol* 2014; 158: 423-435.
- Kranenburg EW. Crater-like holes in the optic disc and central serous retinopathy. *Arch Ophthalmol* 1960; 64: 912-924.
- Sugar HS. Congenital pits in the optic disc and their equivalents (congenital colobomas and colobomalike excavations) associated with submacular fluid. *Am J Ophthalmol* 1967; 63: 298-307.
- Christoforidis JB, Terrell W and Davidoff FH. Histopathology of optic nerve pit-associated maculopathy. *Clin Ophthalmol* 2012; 6: 1169-1174.
- Kuhn F, Kover F, Szabo I and Mester V. Intracranial migration of silicone oil from an eye with optic pit. *Graefes Arch Clin Exp Ophthalmol* 2006; 244: 1360-1362.
- Halbertsma KT. Crater-Like Hole and Coloboma of the Disc Associated with Changes at the Macula. *Br J Ophthalmol* 1927; 11: 11-17.
- Brodsky MC. Congenital optic disk anomalies. *Surv Ophthalmol* 1994; 39: 89-112.
- Yuen CH and Kaye SB. Spontaneous resolution of serous maculopathy associated with optic disc pit in a child: a case report. *J AAPOS* 2002; 6: 330-331.
- Georgalas I, Ladas I, Georgopoulos G and Petrou P. Optic disc pit: a review. *Graefes Arch Clin Exp Ophthalmol* 2011; 249: 1113-1122.
- Sobol WM, Blodi CF, Folk JC and Weingeist TA. Long-term visual outcome in patients with optic nerve pit and serous retinal detachment of the macula. *Ophthalmology* 1990; 97: 1539-1542.
- Uzel MM and Karacorum M. Optic disc pits and optic disc pit maculopathy: A review. *Surv Ophthalmol* 2019; 64: 595-607.
- Hirakata A, Inoue M, Hiraoka T and McCuen BW, 2nd. Author reply: To PMID 22218142. *Ophthalmology* 2013; 120: 878-879.
- Yokoi T, Nakayama Y, Nishina S and Azuma N. Abnormal traction of the vitreous detected by swept-source optical coherence tomography is related to the maculopathy associated with optic disc pits. *Graefes Arch Clin Exp Ophthalmol* 2016; 254: 675-682.
- Kiang L and Johnson MW. Formation of an Intraretinal Fluid Barrier in Cavitory Optic Disc Maculopathy. *Am J Ophthalmol* 2017; 173: 34-44.
- Avci R, Yilmaz S, Inan UU, Kaderli B, Kurt M, Yalcinbayir O, Yildiz M and Yucel A. Long-term outcomes of pars plana vitrectomy without internal limiting membrane peeling for optic disc pit maculopathy. *Eye (Lond)* 2013; 27: 1359-1367.
- Teke MY and Citirik M. 23 Gauge Vitrectomy, Endolaser, and Gas Tamponade Versus Vitrectomy Alone for Serous Macular Detachment Associated With Optic Disc Pit. *Am J Ophthalmol* 2015; 160: 779-785 e772.
- Abouammoh MA, Alsulaiman SM, Gupta VS, Mousa A, Hirakata A, Berrocal MH, Chenworth M, Chhablani J, Oshima Y, AlZamil WM, Casella AM, Papa-Oliva G, Banker AS, Arevalo JF and King Khaled Eye Specialist Hospital International Collaborative Retina Study G. Pars plana vitrectomy with juxtapapillary laser photocoagulation versus vitrectomy without juxtapapillary laser photocoagulation for the treatment of optic disc pit maculopathy: the results of the KESH International Collaborative Retina Study Group. *Br J Ophthalmol* 2016; 100: 478-483.
- Rosenthal G, Bartz-Schmidt KU, Walter P and Heimann K. Autologous platelet treatment for optic disc pit associated with persistent macular detachment. *Graefes Arch Clin Exp Ophthalmol* 1998; 236: 151-153.
- Karacorum M, Sayman Muslubas I, Hocaoglu M, Ozdemir H, Arf S and Uysal O. Long-Term Outcomes of Radial Optic Neurotomy for Management of Optic Disc Pit Maculopathy. *Retina* 2016; 36: 2419-2427.
- Mohammed OA and Pai A. Inverted autologous internal limiting membrane for management of optic disc pit with macular detachment. *Middle East Afr J Ophthalmol* 2013; 20: 357-359.
- Nawrocki J, Boninska K and Michalewska Z. Managing Optic Pit. The Right Stuff! *Retina* 2016; 36: 2430-2432.
- D'Souza P, Babu U and Narendran V. Autologous Free Internal Limiting Membrane Flap for Optic Nerve Head Pit With Maculopathy. *Ophthalmic Surg Lasers Imaging Retina* 2017; 48: 350-353.
- Hara R, Tsukahara Y, Simoyama T and Mori S. Refined Internal Limiting Membrane Inverted Flap Technique for Intractable Macular Detachment with Optic Disc Pit. *Case Rep Ophthalmol* 2017; 8: 208-213.
- Rossi S, D'Alterio FM, Gallo B, Testa F, F S and Della Corte M. New Surgical Technique for The Optic Disc Pit Associated with Macular Hole. *Med Case Rep* 2017; 03: 1-4.
- Sborgia G, Recchimurzo N, Sborgia L, Niro A, Sborgia A, Piepoli M and Alessio G. Inverted Internal Limiting Membrane-Flap Technique for Optic Disc Pit Maculopathy: Morphologic and Functional Analysis. *Retin Cases Brief Rep* 2018;
- Ravani R, Kumar A, Karthikeya R, Kumar P, Gupta Y, Mutha V and Singh S. Comparison of Inverted ILM-Stuffing Technique and ILM Peeling Alone for Optic Disc Pit-Associated Maculopathy: Long-Term Results. *Ophthalmic Surg Lasers Imaging Retina* 2018; 49: e226-e232.
- Caporossi T, Finocchio L, Barca F, Franco F, Tartaro R and Rizzo S. 27-Gauge Pars Plana Vitrectomy With Autologous ILM Transplantation for Optic Disc Pit Maculopathy. *Ophthalmic Surg Lasers Imaging Retina* 2018; 49: 712-714.
- Pastor-Idoate S, Gomez-Resca M, Karam S, Copete S, Kyriakou D, Garcia-Arumi Fuste C, Pastora N, Nadal J and Garcia-Arumi J. Efficacy of Internal Limiting Membrane Flap Techniques with Vitrectomy for Macular Detachment Associated with an Optic Disc Pit. *Ophthalmologica* 2019; 242: 38-48.
- Hirakata A, Hida T, Ogasawara A and Iizuka N. Multilayered retinoschisis associated with optic disc pit. *Jpn J Ophthalmol* 2005; 49: 414-416.
- Spaide RF, Fisher Y, Ober M and Stoller G. Surgical hypothesis: inner retinal fenestration as a treatment for optic disc pit maculopathy. *Retina* 2006; 26: 89-91.
- Theodossiadis GP, Panopoulos M, Kolia AK and Georgopoulos G. Long-term study of patients with congenital pit of the optic nerve and persistent macular detachment. *Acta Ophthalmol (Copenh)* 1992; 70: 495-505.

32. Garcia-Arumi J, Guraya BC, Espax AB, Castillo VM, Ramsay LS and Motta RM. Optical coherence tomography in optic pit maculopathy managed with vitrectomy-laser-gas. *Graefes Arch Clin Exp Ophthalmol* 2004; 242: 819-826.
33. Shukla D, Kalliath J, Tandon M and Vijayakumar B. Vitrectomy for optic disk pit with macular schisis and outer retinal dehiscence. *Retina* 2012; 32: 1337-1342.
34. Marticorena J, Gomez-Ulla F, Romano MR and Fernandez M. Dye-guided retinal laser and internal drainage for optic pit maculopathy. *Graefes Arch Clin Exp Ophthalmol* 2013; 251: 381-382.
35. Jin H, Zhang Q and Zhao P. Fovea sparing internal limiting membrane peeling using multiple parafoveal curvilinear peels for myopic foveoschisis: technique and outcome. *BMC Ophthalmol* 2016; 16: 180.
36. Tripathy K. Spontaneous Resolution of Optic Disc Pit Maculopathy. *Turk J Ophthalmol* 2017; 47: 184-185.
37. Steel DH, Williamson TH, Laidlaw DA, Sharma P, Matthews C, Rees J, Petrou P, Charteris DG, Charles SJ, Patel CK, Crama N, Herbert E and Jackson TL. Extent and Location of Intraretinal and Subretinal Fluid as Prognostic Factors for the Outcome of Patients with Optic Disc Pit Maculopathy. *Retina* 2016; 36: 110-118.
38. Steel DHW, Suleman J, Murphy DC, Song A, Dodds S and Rees J. Optic Disc Pit Maculopathy: A Two-Year Nationwide Prospective Population-based Study. *Ophthalmology* 2018; 125: 1757-1764.
39. Bloch E, Georgiadis O, Lukic M and da Cruz L. Optic disc pit maculopathy: new perspectives on the natural history. *Am J Ophthalmol* 2019;
40. Rayat JS, Rudnisky CJ, Waite C, Huang P, Sheidow TG, Kherani A and Tennant MT. Long-Term Outcomes for Optic Disc Pit Maculopathy after Vitrectomy. *Retina* 2015; 35: 2011-2017.